VOLUME 79 SEPARATE No. 329

PROCEEDINGS

AMERICAN SOCIETY
OF
CIVIL ENGINEERS

NOVEMBER, 1953

AN INTERSTATE ROUTE AND ITS URBAN CONNECTIONS

by D. W. Ormsbee, A.M. ASCE

HIGHWAY DIVISION

{Discussion open until March 1, 1954}

Copyright 1953 by the AMERICAN SOCIETY OF CIVIL ENGINEERS
Printed in the United States of America

Headquarters of the Society
33 W. 39th St.
New York 18, N. Y.

PRICE $0.50 PER COPY

THIS PAPER

--represents an effort by the Society to deliver technical data direct from the author to the reader with the greatest possible speed.

Readers are invited to submit discussion applying to current papers. For this paper the final date on which a discussion should reach the Manager of Technical Publications appears on the front cover.

Those who are planning papers or discussions for "Proceedings" will expedite Division and Committee action measurably by first studying "Publication Procedure for Technical Papers" (Proceedings — Separate No. 290). For free copies of this Separate—describing style, content, and format—address the Manager, Technical Publications, ASCE.

Reprints from this publication may be made on condition that the full title of paper, name of author, page reference, and date of publication by the Society are given.

The Society is not responsible for any statement made or opinion expressed in its publications.

This paper was published at 1745 S. State Street, Ann Arbor, Mich., by the American Society of Civil Engineers. Editorial and General Offices are at 33 West Thirty-ninth Street, New York 18, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Founded November 5, 1852

PAPERS

AN INTERSTATE ROUTE AND ITS URBAN CONNECTIONS

BY D. W. ORMSBEE,[1] A. M. ASCE

[1] Urban Engr., Urban Div., Dept. of Highways, Denver, Colo.

SYNOPSIS

The State of Colorado has within its borders 661 miles of federal-aid highways. This paper traces the development of the north-south highway through the state, the effect it will have on transportation within Colorado, and the cost of its construction. Special attention is given to the choice of the road's particular path and the deficiencies overcome by this highway.

A report on highway needs[2] states that:

[2] "Highway Needs of the National Defense," by Thomas H. McDonald, *House Document No. 249* 81st Cong., 1st Session, May 27, 1949, Chapters 1-2, p. 2.

> "The National System of Interstate Highways is the trunk line highway system of the United States. It connects all the largest cities and most of the larger ones. On its rural sections it serves 20% of the traffic carried by all rural roads. Its urban sections thus far designated, to which further designation will add an almost equal mileage, now serves more than 10% of the traffic moving over all city streets.
>
> This large measure of service is rendered by a network that includes only 1 percent of the country's total mileage of roads and streets. Without doubt, this system forms the most important connected network within the highway system for service of the economy of peace.
>
> The national military establishment has determined that this same system includes in its rural sections substantially the roads of greatest strategic importance for service of the highway necessities of war. The urban sections are rated with the same authority as of prime authority for war-time duty, and the additional urban designation desirable for service of wartime movements is identical in character with the additional needs of normal usage in peace."

This is the basis for the selection of a national system of interstate highways which several governmental groups determined as best serving both civil and military needs of the United States.

The basic highway system was initiated by the Bureau of Public Roads (USBPR) in 1922. At that time the various state highway departments and the USBPR were engaged in selecting routes to comprise the federal-aid system.

The United States War Department responded to a request from the USBPR for information as to the most strategic highways; the map provided by the War Department showed the important highways of the United States. It became known as the "Pershing map," and the highways represented on it were included in the federal-aid system. With revisions to May 15, 1941, this map was approved by the Secretary of War. The system of roads shown on it became known as the "strategic network," and was referred to as such in the Defense Highway Act of 1941.[3,4] The length of highways shown on the Pershing map was 78,800 miles.

[3] "Highway Needs of the National Defense," by Thomas H. McDonald, *House Document No. 249*, 81st Cong., 1st Session, May 27, 1949.

[4] "Toll Roads and Free Roads," *House Document No. 272*, 76th Cong., 2d Session.

On April 14, 1941, Pres. Franklin D. Roosevelt appointed a National Interregional Highway Committee to review data and suggestions presented by the USBPR. The USBPR had suggested that a more limited mileage of trunkline highways could be developed to serve national needs. Acting on the committee's report, the United States Congress directed that:[5]

[5] Federal Highway Act: 1944, Sect. 7, Approved December 20, 1944.

> "There shall be designated within the continental United States a National System of Interstate Highways not exceeding 40,000 miles in total extent so located as to connect by routes, as direct as practicable, the principal metropolitan areas, cities, and industrial centers, to serve the national defense, and to connect at suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico. The routes of the National System of Interstate Highways shall be selected by joint action of the State highway departments of each State and the adjoining States, as provided by the Federal Highway Act of November 9, 1921, for the selection of the Federal-aid system. All highways or routes included in the National System of Interstate Highways as finally approved, if not already included in the federal-aid highway system, shall be added to said system without regard to any mileage limitation."

A system was accordingly selected by the several state highway departments and approved by the Federal Works Administrator, on August 2, 1947. The system approved was composed of 37,681 miles, leaving 2,319 miles of the 40,000-mile limitation for future selection. (It was expected that future selection would consist of circumferential or distributing routes within cities.) Some changes have been made, and Fig. 1 shows the 37,800-mile system.

The Federal Works Administrator submitted to President Roosevelt a report prepared in compliance with a directive from Congress, on the status of the improvements designated in accordance with the provisions of the act of 1944. The report supplemented all previous reports. The President transmitted this report to Congress, with recommendations for its consideration in relation to continuance of federal aid for highway construction.[3]

The system in 1949 included 5,969 miles of streets in urban locales and 31,831 miles of rural roads located outside the limits of all towns and urban areas, representing 2% of all city streets and 1% of all rural roads. As of the 1940 census of the total urban population of the United States, 65% were resident in cities and towns served by the system and 50% of the total rural population was immediately adjacent to the selected routes.

The Interstate System in Colorado

In Colorado, 661 miles of the federal aid system have been approved on the interstate system. These routes are Federal Aid Route 3 (Denver–Julesburg–Nebraska) 182 miles, Federal Aid Route 5 (Denver–Burlington–Kansas) 178 miles, and Federal Aid Route 2 (Wyoming–Denver–New Mexico) 301 miles. Fig. 2 shows the location of these routes.

Design Standards.—The basic standards of road and structural design in the report of the National Interregional Highway Committee have generally been recognized by the American Association of State Highway Officials (AASHO) as embodying the elements of design to produce the highway facilities that are in use, as a long range plan, necessary for the limited mileage of highways to be designated as the "National System of Interstate Highways." In Colorado, design conforms with AASHO standards.[6]

[6] "Design Standard," Am. Assn. of State Highway Officials, August 1, 1945, revised March 15, 1949.

The standards proposed for the Colorado roads are intended for future traffic conditions. For the interim period, stage construction may be permitted and for certain conditions may be necessary to utilize values lower than the suggested minimum standards.

It was decided that the design should accommodate the thirtieth highest hourly traffic density of the year. The system provided safe and efficient facilities to serve mixed traffic of passenger cars, motor buses, trucks, and truck combinations of a volume estimated to be that existing 20 years from the time of construction. Access to the roads was controlled by the purchase of access rights, or by the construction of frontage roads connecting the controlled-access points.

Separation of grades was required for all railroad crossings of two or more main-line tracks—regardless of traffic volume. Separation was justified (regardless of traffic volume) when six or more regular train movements were made on a single track. Protective devices were required at all railroad grade crossings. Vehicular cross traffic at grade was eliminated where design traffic density was 3,000 vehicles per hour or more. Traffic signal controls, channelized intersection, or stop control were used where roads were not separated.

All curves with a curvature greater than 1° were superelevated. Curves sharper than 2° were designed with approach transition curves, and the maximum curvature was consistent with design speed. Sight distance requirements conformed to AASHO policy, with a preferred grade of 5% and an absolute maximum grade of 6%.

Design speeds were determined by use of Table 1 and the degree of curvature was selected by the use of Table 2.

TABLE 1.—The Effect of Locale on Design Speed

Location	Topography	Design Speed, in Miles per Hour	
		Minimum	Desirable
Rural	Flat	60	70
Rural	Rolling	50	60
Rural	Mountainous	40	50
Urban		40	50

TABLE 2.—THE EFFECT OF DESIGN SPEED ON DEGREE OF CURVATURE

Design speed, in miles per hour	DEGREE OF CURVATURE[a]	
	Maximum	Desirable
70	4	3
60	6	5
50	9	7
40	14	11

[a] Based on the equation: Degree of Curvature = 5,730/radius of curvature, in feet.

Where the traffic density per lane was less than 200 vehicles per hour, 11-ft lanes were used. Where density of traffic was 200 vehicles or more per hour, 12-ft lanes were constructed. In urban areas all surfacing or pavement lanes were 12 ft. Where traffic density of 500 vehicles per hour existed (or was anticipated) the initial improvement was patterned to the ultimate development; in the case of density of 800 vehicles per hour or more, a divided highway was constructed. Shoulders were built 10 ft wide, except in mountainous terrain, where a 4-ft width was maintained.

This paper is concerned with the status (as of 1953) and development of Federal Aid Route 2, called the "north-south route," through Colorado between Wyoming and New Mexico. This route is a part of the interstate highway system and it passes through the cities of Denver, Colorado Springs, Pueblo, Walsenburg, and Trinidad, and is close to Ft. Collins, Loveland, Longmont, Greeley, Boulder, Golden, Aurora, Englewood, and Canon City. These fourteen of the twenty-one cities in Colorado with a population of 5,000 or more have a total population of 648,919—or 48.9% of the state's population of 1,325,089, and 78% of the population of all the cities. With the traffic on this road carrying the products of all phases of civilian and military enterprises, it is a vital part of the state and national economy.

The condition of this highway (as of 1951) is indicated in Fig. 2(*a*). The sufficiency rating was prepared by the planning and research division of the department of highways. With ratings based on structural adequacy, par 40; safety, par 30; and service, par 30; the condition of the route was as follows:

Sufficiency Rating	Percent of Route	Miles
80 to 100	46.4	140
70 to 79	32.0	96
Less than 70	14.0	42
Within cities	7.6	23

The appropriation for 1952 construction provided for approximately $3,670,000 for improvement of the route outside the cities. This was allocated to reconstruct the 42 mile-roadway having a sufficiency rating of less than 70.

Fig. 3(*b*) is a graph showing the estimated practical capacity of the route, and the sections where surpluses or deficiencies in roadway capacity exist. Fig. 3(*c*) is a graph showing the capacity of a two-lane highway, fully developed as permitted by the terrain, with its deficiencies or surplus capacities for the traffic anticipated for 1972.

From Fig. 3 it can be seen that:

1. The sections on Federal Aid Route 2 indicated as overloaded correspond to sections rated under 80 on the sufficiency study, and the funds allocated for the 1952 construction program were properly assigned by the chief engineer and advisory board to correct the sections given lower rating.
2. The remainder of the route with a rating of less than 80 is in need of improvement.
3. The two-lane sections constructed to full standard will reach full practical capacity and hence require additional treatment.
4. The route from Walsenburg to Ft Collins, assuming that traffic follows the estimated percentage of increase, must be improved beyond the capacity of a fully-developed two-lane road. Certain sections appear to require immediate attention.

The preparation of Fig. 3 was based on the data and methods outlined in a manual of the USBPR.[7] Fig. 3 is also based on a rural, two-way, two-lane highway having an estimated practical capacity of 900 vehicles per hour and a rural multilane road having an estimated practical capacity of 1,000 vehicles per lane in each direction. It was also assumed that (*a*) trucks will comprise 20% of this traffic, (*b*) the peak hour rate will be 16% of the annual average daily volume, and (*c*) the traffic in 1970 will be 2.2 times greater than the traffic in 1950.

[7] "Highway Capacity Manual," Bureau of Public Roads, U. S. Dept. of Commerce, Washington, D. C., 1950.

Traffic-capacity graphs (Fig. 3(*c*)) have been prepared to supplement the sufficiency rating study and to give an indication of the required development of the route necessary for anticipated traffic volumes. The sufficiency rating (Fig. 3(*a*)) is the analysis of the route as to traffic volumes and road conditions.

Urban Developments and Plans

With the exception of the City of Walsenburg, plans for the urban developments are all past the stage of preliminary agreement with the cities concerned and the USBPR (as of 1953). General agreement on route and type of facility has been reached for Colorado Springs, and construction has been initiated in the remainder of the cities.

Denver.—Preliminary plans for the development of a north-south route were prepared in 1944 by H. S. Crocker and A. J. Ryan, Members, ASCE, at the request of the state highway department. The route selected is shown in Fig. 4. It was approved and adopted by the City of Denver, the United State Public Roads Administration, and the state highway department. Messrs. Crocker and Ryan were commissioned to prepare plans for construction and acquisition of right of way for 4.7 miles of the 10.4-mile project. These plans were completed and delivered in 1946. Construction plans for the remaining 5.7 miles were prepared by the Colorado State Highway Department, Urban Division. All construction is managed and directed by the urban division, and approximately 40% of the route has been completed or is under contract. All right of way is being acquired and cleared to foundation level by the City of Denver, with its own funds or with financial assistance from state of federal funds on a matching basis.

Origin and Destination Studies.—Origin and destination studies were made by the University of Denver, and traffic assignments were made by the state highway planning division and the USBPR.

Alternate Route Studies.—The main highways entering Denver tend to concentrate traffic in a north-south direction. Alternate routes, receiving study prior to the adoption of the Valley Highway route were Federal Boulevard, Broadway, and Colorado Boulevard. Broadway afforded the most direct and desirable location, but it was prohibitive in cost.

The location along the Platte River lowlands (Valley Highway) was selected as the most economical in construction and right of way. It was deemed superior to other routes also in respect to distribution and access to objective points of traffic. Not included in the Valley Highway plan itself, but developed by Messrs. Crocker and Ryan, was the Market Street plan. This route is complementary to the freeway plan, giving direct access to the principal industrial and commercial area of the city from Valley Highway. The construction of this route or a similar route was necessary to develop the full potential of Valley Highway.

Valley Highway, 10.4 miles long, extends from the northern city limit of Denver at West 52d Avenue to South Colorado Boulevard. On the north, there is a four-lane expressway for 2 miles, and funds were provided for an additional 6 miles on the interstate route, with a connection to the Boulder Turnpike. To the south, the interstate route is completed to Castle Rock, as a high-type, two-lane, concrete-pavement highway with four lanes provided on grades over 4%.

The Valley Highway route within the city is a freeway. Access rights have not been secured, but sufficient width of right of way has been acquired to provide space for outer highway construction to protect the freeway. A typical section of the highway is shown in Fig. 5.

Colorado Springs.—Colorado Springs is situated on US 85-87 at its junction with US 24 and State Highway 94 on the east and US 24 on the west. Including Broadmoor, Manitou, and other developments, these highways serve a population of more than 75,000 people. This area is the gateway to the Pikes Peak region and scenic areas to the west, and tourist travel is important to the area. Mining and agriculture are basic industries, and considerable development has occurred in industrial plant location.

This city has wide north-south streets. Nevada Avenue, the route of US 85-87, has two 30-ft lanes separated by a wide median. Parallel streets have a similar capacity. These streets all traverse highly-developed residential areas.

Three major routes were made the basis of study for a through route—the Union Avenue route (on the eastern edge of the city), the Shooks Run route (following a railroad line through the center of the city), and the Walnut Street route (following the west side of Monument Creek and the Denver and Rio Grande Western Railroad). After traffic analysis, community service, service to the western half of the city, and lower costs of construction and right of way, the Walnut Street route was selected. This route by-passes most of the superior residential areas and diverts through truck travel from inadequate routes. The length of the route is 4 miles, and its estimated cost is $4,500,000.

Pueblo.—Pueblo is situated on US 85-87 at its intersection with US 50, a prime east-west highway crossing Colorado. State Highways 76 and 96 enter from the west, and State Highway 96 continues to the east.

This city is a natural trading center served by four main-line railways. Steel mills were active in 1882, and the plants of the Colorado Fuel and Iron Company form an integral part of Pueblo's economy. The irrigation development of the Arkansas River Valley has been a sound basis for city growth. The Pueblo Ordnance Depot, located east of the city, is a major factor in the economic life of the city.

Plans for an expressway, with part of the route a freeway, were initiated in 1946. In addition to providing a rapid-transit facility for through traffic, with ample approaches to the business area, the expressway serves to a higher degree any similar facility on which the state has planned the movement of intracity peak-hour traffic from the industrial areas to the residential sections of the city. The expressway is a four 12-ft lane divided highway with a 30-ft median area and 10-ft shoulders. The length within the city limits is 5.4 miles. The over-all length of expressway, freeway, and connections is 8.3 miles.

The cost of the entire development was $7,500,000, of which $677,000 was expended prior to 1953.

Walsenburg.—Walsenburg is located at the junction of US 85-87 and State Highway 10 from the east, US 160 to the west, and State Highway 69 to the northwest. Through this city much of the traffic flows which originates in the San Luis Valley and the Durango areas of Colorado.

Traffic volumes of less than 3,000 vehicles per day (annual average) on the interstate route have not required urban development. The length of the urban route is 1.2 miles. It is estimated that $1,000,000 will be necessary for possible right of way and construction within urban limits.

Trinidad.—Trinidad is the county seat of Las Animas County. It is the business center and distributing point for a large area in the southern part of the state, serving the needs of the livestock, coal mining, railroad, lumber, and agricultural industries. To the west of the city the Tercio, Monument Lake, and Cucharis Camps districts comprise the principal recreational area east of the continental divide in the southern half of the state. Agricultural and livestock products originate in the east.

Highways serving Trinidad from north and south are State Highway 1 (US 85-87); from the east, State Highway 12 (US 350); and from the west, State Highway 12. The business district has developed along and near the main intersection of these routes, developing a very unsatisfactory traffic condition.

The expressway plan for the city is primarily a by-pass route to relieve this unsatisfactory condition and to provide a free-flowing route for trucks and through traffic.

The cost within urban limits prior to 1953 was $425,000, and the cost of the completed urban section was $2,000,000. The southerly connection cost $200,000.

Conclusion

The approximate estimate costs to complete in 1953 the urban developments for cities on the interstate route are as follows:

Denver	$15,000,000
Colorado Springs	4,500,000
Walsenburg	1,000,000
Pueblo	6,000,000
Trinidad	1,000,000
Total	$27,500,000

Federal funds allocated for urban projects in 1952 were $1,006,137, which provided a $1,800,000 construction program when supplemented by state funds. If all the urban funds were applied to these cities, more than 15 years would elapse before the planned improvements would be completed. Since these are but five of the twenty-one cities now eligible for these funds, the time for completion would necessarily be greater.

It appears that, if these facilities are to be constructed to meet 1953 traffic demands, some method of financing other than annual budgets on allocated funds must be developed.

FIG. 1.—NATIONAL SYSTEM OF INTERSTATE HIGHWAYS IN THE UNITED STATES

FIG. 2.—FEDERAL AID ROUTES IN COLORADO

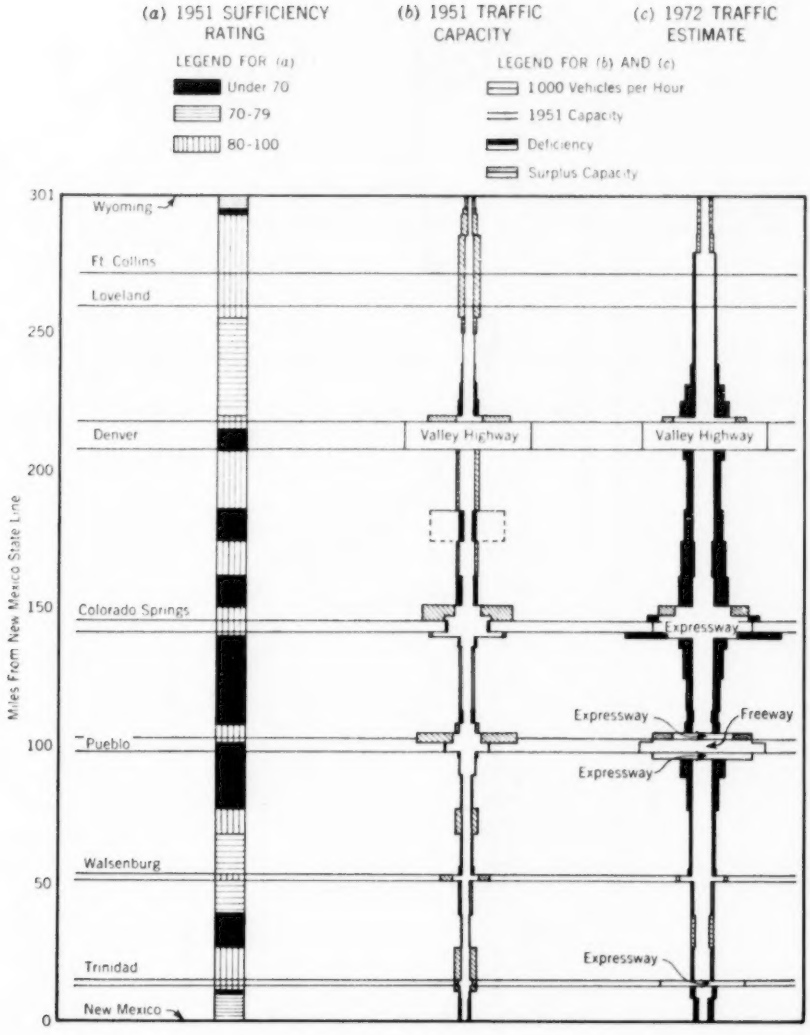

FIG. 3.—FEDERAL AID ROUTE 2 SUFFICIENCY AND CAPACITY

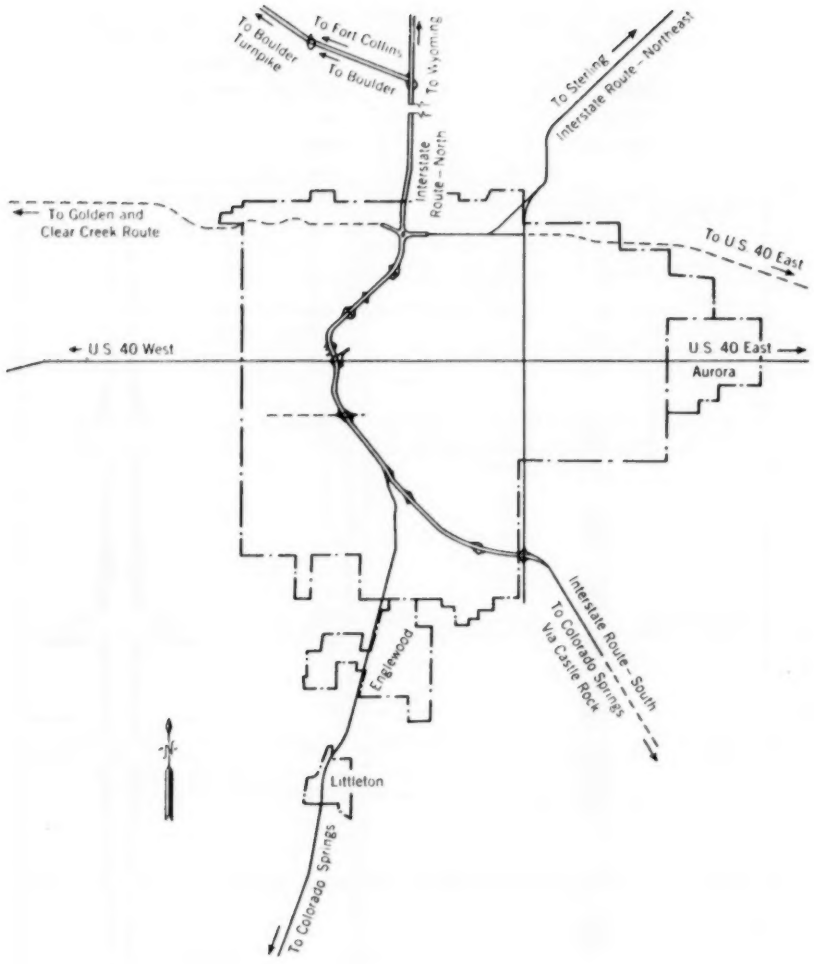

FIG. 4.—VALLEY HIGHWAY IN DENVER, COLO.

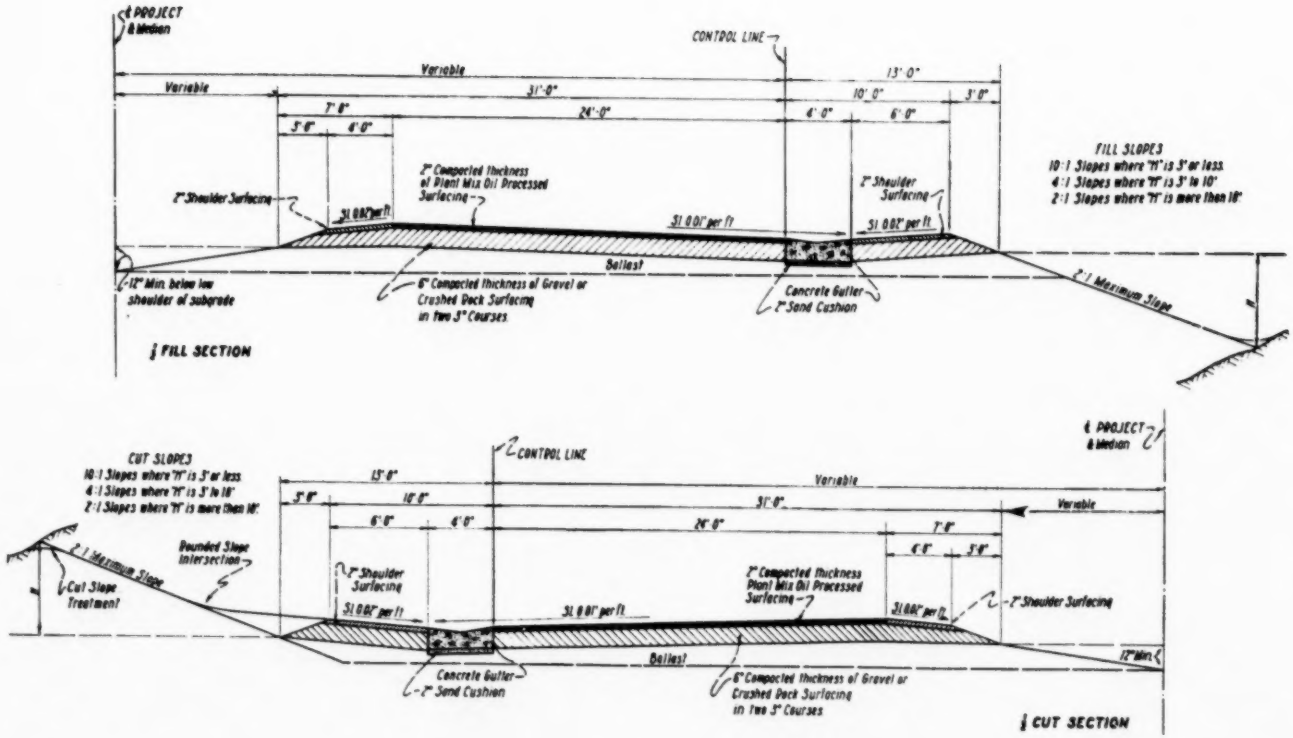

FIG. 5.—TYPICAL SECTIONS OF THE VALLEY HIGHWAY